October 22, 2007

**SUMMARY OF SUBJECT MATTER**

**TO:** Members of the Subcommittee on Highways and Transit

**FROM:** Subcommittee on Highways and Transit Staff

**SUBJECT:** Hearing on "Highway Bridge Inspections"

## PURPOSE OF HEARING

The Subcommittee on Highways and Transit will meet on Tuesday, October 23, 2007, at 2:00 p.m., in room 2167 Rayburn House Office Building, to receive testimony regarding highway bridge inspections. Witnesses scheduled to testify include the Federal Highway Administration Associate Administrator for Infrastructure, the Director of the Oregon Department of Transportation, a level two bridge inspector from the Minnesota Department of Transportation, a National Director of Bridge and Tunnel operations and an academic expert.

## BACKGROUND

### I-35W MISSISSIPPI RIVER BRIDGE

At 6:05 p.m. on August 1, 2007, the I-35W Bridge in Minneapolis, Minnesota, collapsed into the Mississippi River, killing 13 people. The eight-lane, steel truss bridge span, which was constructed in 1967, carried approximately 140,000 vehicles daily. The National Transportation Safety Board is conducting an investigation into the cause of the collapse. The investigation may take up to 18 months to complete.

In response to concerns over the design of the bridge, U.S. Secretary of Transportation Mary Peters requested that States inspect 756 bridges with a similar steel arch truss design.

It has been widely reported that inspections of the I-35W Bridge raised significant structural concerns with the facility. The bridge had been rated as structurally deficient since 1990, and had undergone annual inspections by the Minnesota Department of Transportation ("MnDOT") since 1993.

The most recent inspection completed in June 2006 found cracking and fatigue problems, and gave the bridge a sufficiency rating of 50 percent on a scale of 0 to 100 percent. A rating of 50 percent or lower means the bridge should be considered for replacement.

In December 2006, the bridge was to have undergone a $1.5 million steel reinforcement project to strengthen the bridge. However, MnDOT cancelled the project because of concerns that drilling for the retrofit could weaken the bridge. Alternatively, MnDOT implemented a program of periodic inspections to monitor the bridge.

## HIGHWAY BRIDGE CONDITIONS IN THE UNITED STATES

According to the U.S. Department of Transportation ("DOT"), one of every eight bridges in the nation is structurally deficient. Of the 597,340 bridges in the United States, 154,101 bridges are deficient, including 73,784 structurally deficient bridges and 80,317 functionally obsolete bridges.

According to DOT, more than $65 billion could be invested immediately in a cost-beneficial way, by all levels of government, to replace or otherwise address existing bridge deficiencies.[1]

The high percentage of deficient bridges and the backlog of necessary bridge repairs are, in part, due to the age of the network. One-half of all bridges in the United States were built before 1964. Interstate System bridges, which were primarily constructed in the 1960s, pose a special challenge because a large percentage of these bridges are in the same period of their service lives (e.g., 44 percent of these bridges were constructed in the 1960s). Concrete and steel superstructures on the Interstate Highway System are, on average, 35 to 40 years old.

Bridges are considered structurally deficient if significant load-carrying elements are found to be in poor or worse condition due to deterioration and/or damage. The fact that a bridge is "deficient" does not immediately imply that it is likely to collapse or that it is unsafe. With hands-on inspection, unsafe conditions may be identified and, if the bridge is determined to be unsafe, the structure must be closed. A "deficient" bridge, when left open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies.

In a 2006 audit of structurally deficient bridges on the National Highway System ("NHS"), the DOT Inspector General ("IG") illustrated common causes of structural deficiency.[2]

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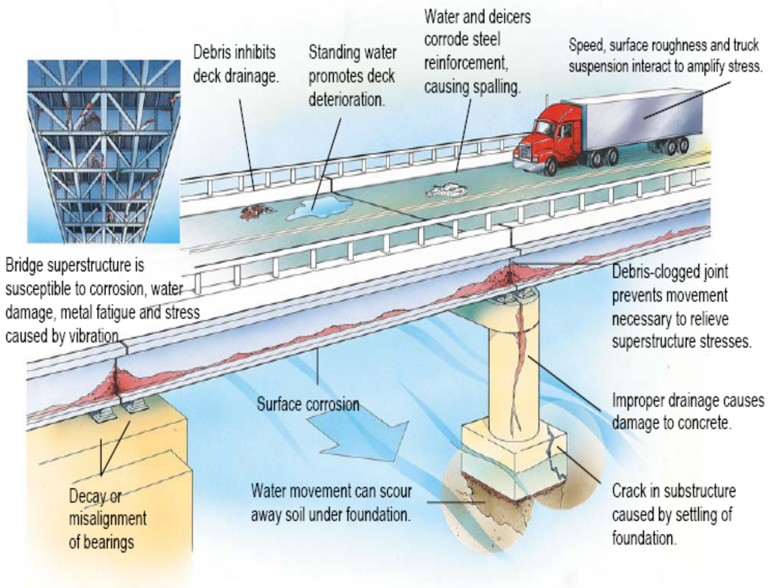
[1] U.S. Department of Transportation, *2006 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*, January 22, 2007, p. 7-17. The economic backlog of bridge deficiencies consists of all improvements to bridge elements that would be justified on both engineering and economic grounds. It includes improvements on bridges that warrant repair but whose overall condition is not sufficiently deteriorated for the bridges to be classified as structurally deficient. *Id.*, p. 7-16.

[2] U.S. Department of Transportation Inspector General, *Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System*, MH-2006-043, March 21, 2006, p. 2.

HOW BRIDGES BECOME STRUCTURALLY DEFICIENT




Source: Illustration by Jana Brenning. Copyright Jana Brenning. Reprinted with permission. Illustration first appeared in Scientific American, March 1993.

The primary considerations in classifying structural deficiencies are the bridge component conditional ratings. The National Bridge Inventory contains ratings on the three primary components of a bridge: the deck, superstructure, and substructure. Bridge inspectors assign condition ratings by evaluating the severity of the deterioration or disrepair and the extent that it has spread through the component being rated.[3] Condition ratings of 4 and below indicate poor or worse conditions and result in structural deficiencies.

Bridge Condition Rating Categories[4]

| Rating | Condition Category | Description |
|---|---|---|
| 9 | Excellent | |
| 8 | Very Good | |
| 7 | Good | No problems noted. |
| 6 | Satisfactory | Some minor problems. |
| 5 | Fair | All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour. |

[3] The condition ratings provide an overall characterization of the general condition of the entire component being rated and an indication of localized conditions.
[4] U.S. Department of Transportation, *2006 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance*, January 22, 2007, Exhibit 3-9.

| | | |
|---|---|---|
| 4 | Poor | Advanced section loss, deterioration, spalling, or scour. |
| 3 | Serious | Loss of section, deterioration, spalling, or scour have seriously affected the primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present. |
| 2 | Critical | Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may be removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken. |
| 1 | Imminent Failure | Major deterioration or section loss present in critical structural components, or obvious loss present in critical structural components, or obvious vertical or horizontal movement affecting structural stability. Bridge is closed to traffic, but corrective action may put back in light service. |
| 0 | Failed | Out of service; beyond corrective action. |

## LOAD RATINGS AND POSTINGS ON STRUCTURALLY DEFICIENT BRIDGES

Deteriorating conditions on deficient bridges results in facilities being "load rated". The load rating is an estimate of the weight-carrying capacity of a bridge and is performed separately from the bridge inspection.[5] Properly calculating the load rating of structurally deficient bridges, and, if necessary, posting signs to keep heavier vehicles from crossing them, serves to protect structurally deficient bridges from powerful stresses caused by loads that exceed a bridge's capacity.

In the 2006 audit, the IG found that States erred in calculating the load rating for structurally deficient bridges on the NHS. According to the DOT IG, inaccurate or outdated maximum weight limit calculations and posting entries were recorded in bridge databases of the state departments of transportation and the National Bridge Inventory. The IG projects that among structurally deficient bridges on the NHS:

- one of 10 structurally deficient NHS bridges had load rating calculations that did not accurately reflect the condition of the structure;

- signs were not posted on 7.8 percent of bridges that were required to have maximum safe weight signs posted; and

[5] U.S. Department of Transportation Inspector General, *Audit of Oversight of Load Ratings and Postings on Structurally Deficient Bridges on the National Highway System*, MH-2006-043, March 21, 2006, p. 3.

- procedures were not properly followed in the calculation of load ratings for 10 percent of the bridges.[6]

The IG also found that Federal Highway Administration ("FHWA") Division Offices did not ensure that States' bridge load ratings were properly calculated and corresponding postings were performed. In addition, FHWA does not require its Division Offices to analyze bridge inspection data to better identify and target specific structurally deficient bridges most in need of load limit recalculation and posting.[7]

**Federal Bridge Program and Bridge Inspection Standards**

In December 1967, the Silver Bridge, which ran between Point Pleasant, West Virginia and Gallipolis, Ohio, collapsed, killing 46 people. The following year, Congress passed the Federal-Aid Highway Act of 1968, which established the National Bridge Inspection Program (NBIP), and directed DOT to work with the States to establish national bridge inspection standards designed to locate and evaluate existing bridge deficiencies to ensure the safety of highway bridges. The Act required DOT to establish inspection criteria and procedures, and inspector training and qualification requirements. The Act also required States to prepare and maintain an inventory of Federal-aid Highway system bridges.

In 1971, DOT published the National Bridge Inspection Standards ("NBIS") in the Federal Register. Under the NBIS, States are required to conduct routine safety inspections on each bridge at least once every 24 months to determine physical and functional conditions of the bridge. The minimum federal requirement of routine inspections consists of "observations and measurements needed to determine the physical and functional condition of the bridge, to identify changes in 'initial' or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements."[8] Routine inspections are generally visual. States, however, often utilize additional technology or mechanical techniques to carry out more in-depth inspections depending on the condition and nature of the structure. Types of inspections include:

- *Initial*—First inspection of a bridge, to provide a structural inventory and a baseline of structural conditions, including identification and listing of existing problems or locations in the structure that may require special attention.
- *Routine*—Regularly scheduled inspections to determine physical and functional condition of the bridge.
- *In-Depth*— Close-up, hands-on inspection of one or more bridge components to identify potential deficiencies not detectable using routine inspection procedures.
- *Special*—Regular inspections to monitor a specific known or suspected deficiency.
- *Damage*—Unscheduled emergency inspection to determine structural damage resulting from accident or other external incident.[9]

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[6] *Id.*, p. 6.
[7] *Id.*, p. 13.
[8] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges,* Second Edition, p. 11.
[9] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges,* Second Edition, p. 11-13.

Information is collected during inspection documenting the conditions and composition of the structures. The periodic inspections determine the adequacy of the structure to service the current demands for structural and functional purposes. Each State's Department of Transportation performs bridge inspections. This information is maintained in the National Bridge Inventory maintained by the FHWA.

The Surface Transportation Assistance Act of 1978 expanded the NBIS to include bridges on all public roads, including bridges not on the Federal-aid Highway system. With an expanded inventory of bridges to be inspected, FHWA decided to lengthen the time between inspections. In 1988, FHWA issued regulations extending inspection intervals for certain bridges based on findings and analysis from previous inspections. The inspection interval for these bridges may not exceed once every 48 months. However, States are still required to conduct routine inspections on each bridge once every 24 months unless the state receives approval from FHWA to expand the inspection interval.

According to the FHWA, 83 percent of bridges are inspected once every 24 months, 12 percent are inspected at least annually, and 5 percent are inspected at least once every 48 months.

The Surface Transportation and Uniform Relocation Assistance Act of 1987 required additional inspection requirements for components that are critical to the safety of the structure. This included fracture critical members and underwater structures.[10] Inspections for underwater structures must occur once every 60 months. Under the 1988 rulemaking, FHWA may extend the inspection interval for certain underwater structures based on findings and analysis from previous inspections. The inspection interval for underwater structures may not exceed once every 72 months.

The Secretary uses funds made available for the U.S. DOT's administrative expenses and the Surface Transportation Research Program to implement the NBIS highway bridge inspection program. States use Highway Bridge Program funds to carry bridge inspection activities.

## Bridge Inspector Training and Qualification Requirements

Federal regulation currently sets minimum qualifications of the top two levels of personnel responsible for carrying out bridge inspections. Specifically, the regulations set minimum qualifications required for a Program Manager and a Team Leader.[11]

- *Program Manager*—This is the individual in charge of the overall management and supervision of a State's bridge inspection program. Minimum qualifications for the Program Manager includes:
    - Registered professional engineer; or
    - Be qualified as a professional engineer under the laws of the State; or

[10] Fracture critical members are bridge components "whose failure will probably cause a portion of or the entire bridge to collapse." U.S. Department of Transportation, Federal Highway Administration, "National Bridge Inspection Standards," 53 Federal Register, August 26, 1988, p. 32616.

[11] Underwater bridge inspector and the individual responsible for determining load ratings for bridges are also required to have a minimum level of training.

- Have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the *Bridge Inspector's Training Manual*.

- *Team Leader*—This is the second level of bridge inspection responsibility. A team leader must be on site during bridge inspections. Team leaders are responsible for planning and performing field inspections of bridges. Minimum qualifications for a team leaders include:
  - Have qualifications specified for Program Leader; or
  - Have a minimum of five years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the *Bridge Inspector's Training Manual*; or
  - National Institute for Certification in Engineering Technologies Level III or IV certification in Bridge Safety Inspection.[12]

Federal regulations do not require "front-line" bridge inspectors to receive a minimum level of training. Many states, however, provide training for all levels of inspectors through the National Highway Institute and/or other state-based organizations offering FHWA–approved comprehensive training and certification programs.

## Technology and Research and Development

Visual observation and other traditional means of observation (such as cleaning and scraping, chain drags, and use of sounding rods and hammers) remain the primary methods of conducting field tests of bridge elements. A study released by the FHWA Destructive Evaluation Center in 2001 raised significant concerns over the reliability of visual inspections. The 2001 report found that visual inspections by 49 trained bridge inspectors from around the country of bridges with identified fatigue problems rarely detected defects. In fact, the study found that only eight percent of the inspectors correctly identified a fatigue crack, and many of the inspectors identified non-existent problems.

To supplement and enhance traditional testing methods, state-of-the-art techniques are increasingly being utilized to augment and advance examination of critical or suspect bridge elements. The types of methods being developed and utilized by states include: impact echo, infrared thermography, ground penetrating radar, strain gauges, ultrasonic, eddy current, radiography, acoustic emissions, x-ray technology, and other non-destructive evaluation techniques.

FHWA, industry, academia, the Transportation Research Board, and State DOTs continue to research, investigate, and develop bridge inspection technologies. To assist in this effort, Congress authorized and funded FHWA bridge research efforts as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users ("SAFETEA-LU"). The research is focused on five bridge program areas: long-term bridge performance, innovative bridge delivery, high performance and innovative materials, nondestructive inspection technology, and seismic research.

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[12] American Association of State Highway and Transportation Officials, *Manual for Condition Evaluation of Bridges,* Second Edition, p. 13.

## MANAGEMENT SYSTEM

Most states have developed some form of computer-based bridge management programs. These systems are utilized to assist states in managing bridge programs to improve the bridge inspection process and quality of data collected and reported to the National Bridge Inventory (NBI). These systems also assist states in prioritization of system-wide investment decisions based on the needs of the bridges, and tracking the deterioration rate of bridge elements. The bridge management systems currently being utilized by states, however, vary in complexity and capabilities.

In addition to assisting states in managing bridge programs, computerized management systems could provide FHWA with an effective oversight tool. In the 2006 audit, the IG recommended that FHWA utilize the objective data generated from the NBI and state databases to improve oversight and risk assessments of state bridge programs.

## Witness List

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